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Maps Connecting the World

Encrypted Cartographic Masking for Geospatial Privacy Protection in Location Based Services

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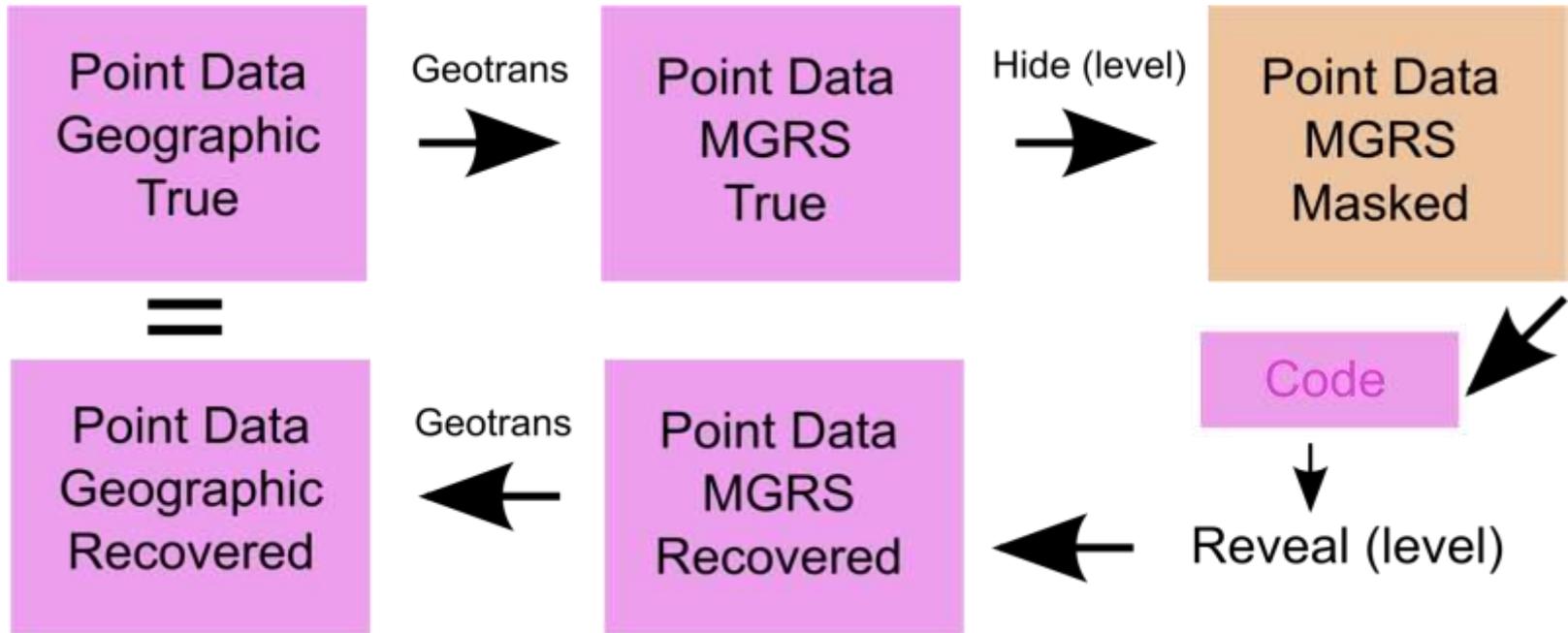
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Point Set Masking Methods

- Aggregation
- Movement to grid centers
- Move to street/tract center
- Anonymization (but reverse geocoding)
- Affine transformation
- Random or localized displacement

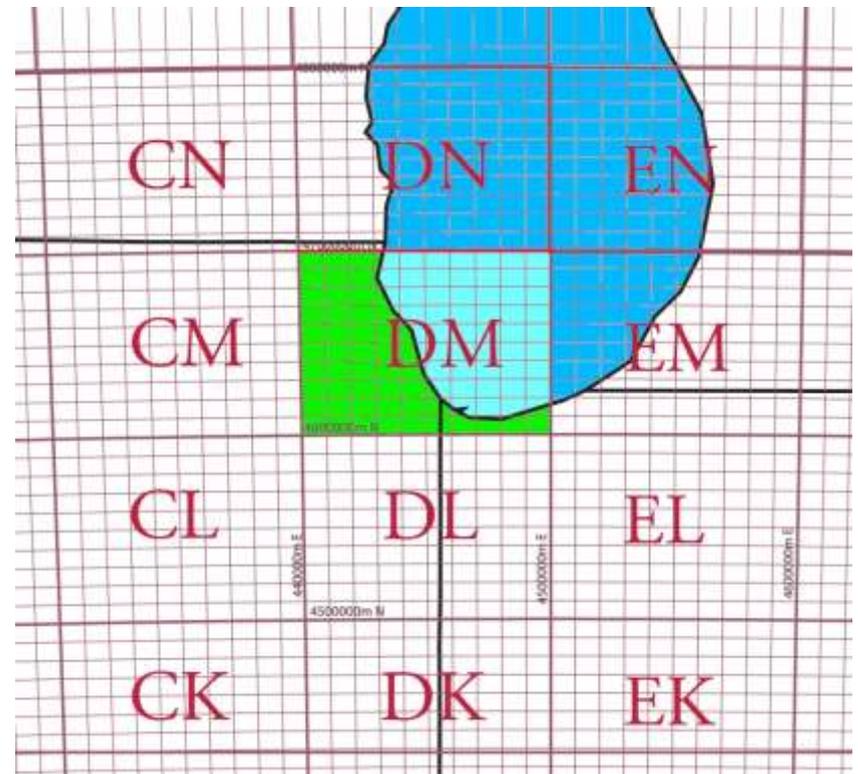
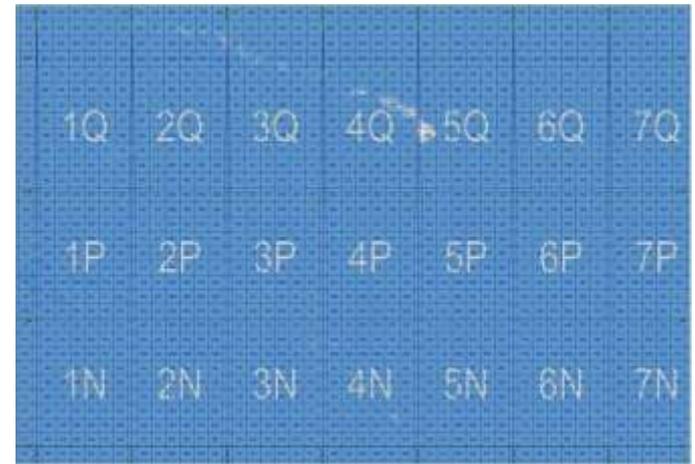
New method: Multiscale digit switching



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MGRS

- Initial UTM zone number
- Grid cell designator
- Cell square identifier
- Easting 0-999999
- Northing 0-999999



Step 1: Use NGA's GEOTRANS

- Original point set in lat, long + datum
- Put into GEOTRANS .DAT format
- Use GEOTRANS to convert to MGRS



2. Use custom program “hide”

- 10 digits to replace
- 1.3M possible combinations that assure all digits are altered
- Each combination is tried, but with replacement only for specific digit places (Brute Force)
- For each coding, compute set of metrics for new point set, compare with original
- Includes extremes, means, medians, standard deviations in x and y
- Multiply difference sum by difference in nearest neighbor statistic
- Retain code with the smallest difference from the original point set's statistics

For example

Level 3	MGRS coordinate	UTM Zone Number	Grid Cell Designator	Cell Square Identifier	Easting	Northing
Original Point	10SEG4079590435	10	S	EG	40795	90435
Encoded Point	10SEG4031490684	10	S	EG	40314	90684
Code key	10SEG9758640321	NA	NA	NA		

0	maps to	9		Code last 3 digits	**795	**435
1	maps to	7		7 maps to 3	**395	**435
2	maps to	5		9 maps to 1	**315	**435
3	maps to	8		5 maps to 2	**312	**435
4	maps to	6		4 maps to 5	**312	**535
5	maps to	4		3 maps to 7	**312	**572
6	maps to	0		2 maps to 8	**312	**578
7	maps to	3		Complete	40312	90578
8	maps to	2		MGRS Encoded	10SEG4031490684	
9	maps to	1				

GPS trace: Golden Gate National Recreation Area, California



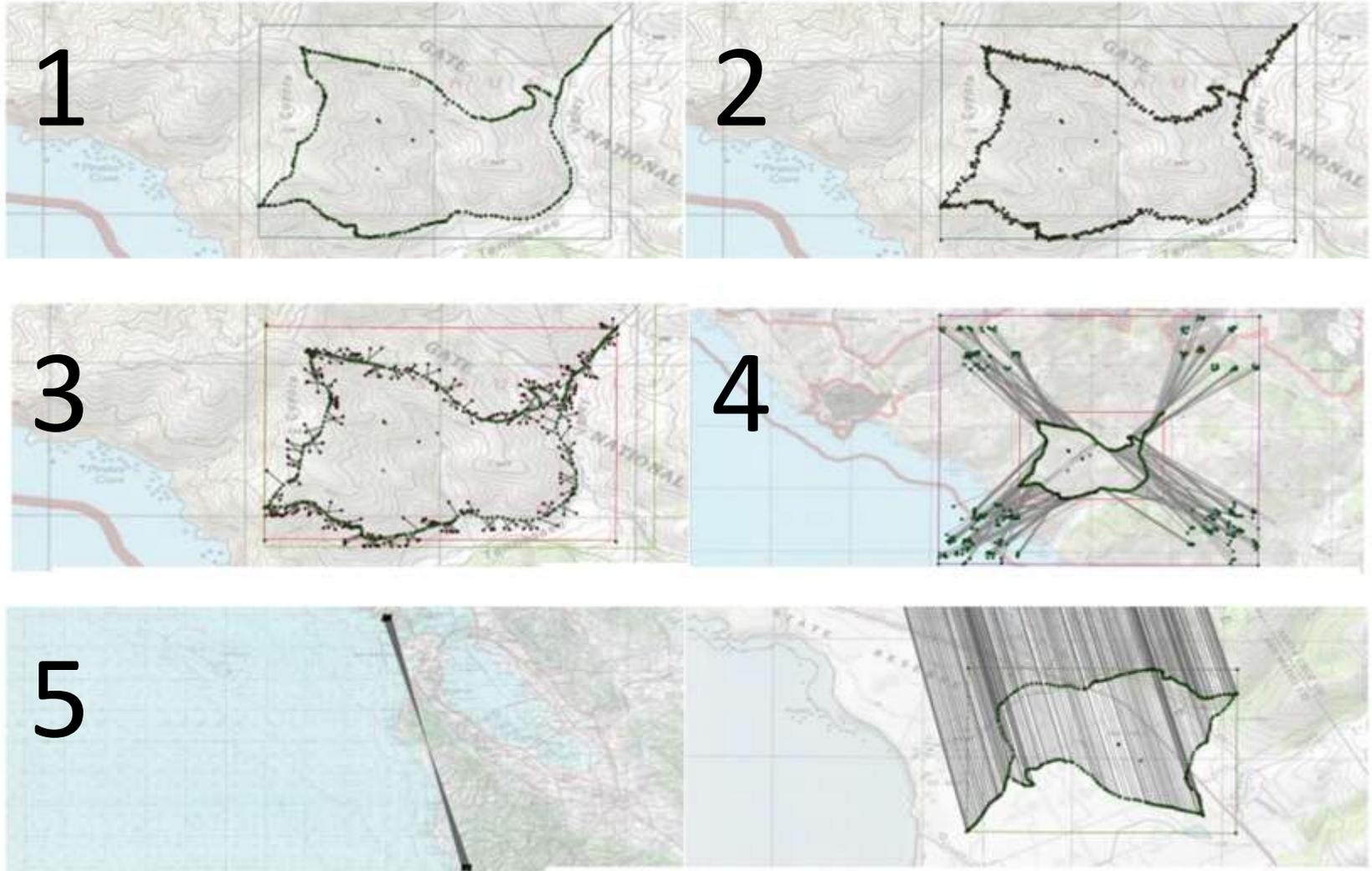
Applied to last two digits



Level 2 detail



Impact of scale/resolution



Conclusion



- Masking can be customized by scale
- Displacements from minimum to complete masking
- Spatial statistics for whole distribution preserved
- Code “reveal” takes stored code and inverts exactly
- Data + code contains all information, and aggregate statistics match
- Equivalent to lock and key for point data

Availability

- Code released to public domain on SourceForge
multiscalemaskingofpoints.sourceforge.net
- Geotrans: earth-info.nga.mil/GandG/geotrans
- Paper: Clarke, K. C (2015) “A Multi-scale Masking Method for Point Geographic Data” in press at *International Journal of Geographic Information Science*

